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(54) CATHODE ASSEMBLIES FOR THE ELECTRODEPOSITION OF METALS

(71) We, THE INTERNATIONAL NICKEL COMPANY OF CANADA, LIMITED, a Canadian Company, of Copper Cliff, Ontario, Canada, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to cathode assemblies for the electrodeposition of metals.

The present practice in the electrolytic refining of copper is to deposit the copper upon thin sheets of high purity copper known as starting cathodes or starting sheets. These starting sheets are produced by electrolytically depositing copper for a period of about 24 hours on rigid mother blanks of rolled copper. The deposits form on both faces of the blanks and must then be stripped from the blanks. After stripping, the starting sheets are used as cathodes in an electrolytic refining cell with crude copper anodes, and when relatively heavy deposits of copper have been formed on them the starting sheets, with the deposited copper, are melted into ingot or bar or other suitable forms of high purity copper for further processing.

More recently, it has been proposed to deposit copper directly from the anodes upon the faces of a suitable laminar cathode blank for prolonged periods to obtain heavy deposits of high purity copper, which are then stripped from the cathode blanks. The need to produce and use intermediate starting sheets is thereby eliminated.

The stripping operation is made more difficult and costly if copper deposited on the edge faces of the cathode blank joins the two major face deposits. Where starting sheets are produced, various means are used to strip the face deposits from the cathode blanks, generally leaving the edge deposits behind to be stripped in a separate operation. The edge copper thus stripped is largely scrap, which may be remelted as anode copper and again undergo electrolytic refining. Where heavy deposits are formed, a

thick plate which envelopes the blank effectively prevents stripping.

Similar problems arise in the electrorefining of other metals, and there is a need for a practical and economical means of preventing the deposition of metal at the edge faces of the cathode blank and facilitating stripping of the deposited metal.

According to the invention this is achieved by providing a cathode assembly comprising a laminar cathode blank having faces, including a bottom edge face and two side edge faces, on which a removable electrodeposit of metal can be formed, with the bottom edge face having a V-section groove extending longitudinally therein to facilitate removal therefrom of an electrodeposit when formed thereon, and further comprising stretchable, electrically insulating masks adapted to be removably shrink-fitted over the side edge faces to prevent electrodeposition of metal thereon and thereby facilitate removal from the blank of an electrodeposit when formed on the blank.

The term 'shrink fitted' in this specification and claims refers to the fit obtained primarily by elastic shrinkage, by first stretching the masks, placing them on the cathode blank in the stretched condition and then releasing them into engagement with the blank so that they remain under residual tension. The stretching and fitting operation may be facilitated by heating the masks, but this is not essential.

The materials used for the masks should have a low modulus of elasticity to permit the requisite stretching and should be hydrophobic to prevent electrolyte from reaching the masked surface of the cathode blank. Preferably the masks are made of polypropylene, but other non-conductive corrosion resistant materials such as fluorocarbons, polyethylenes, polycarbonates, polyolefins, ABS resins, polyvinyl chloride and copolymers thereof may also be used.

It will be appreciated that each side edge face of the cathode blank fits into a channel

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recessed in a mask, and advantageously the mask is mechanically retained in position by engagement between dovetailed or other suitably shaped retaining surfaces formed at the extremities of the side edge faces of the blanks and corresponding surfaces inside the ends of the channel.

To prevent metal from building up under the masks during the electrodeposition, they should fit closely on the blank, and the cross-section of the channel is preferably so shaped that there is line contact between the edges of the channel and the faces of the blank. If desired, the portions of the blank over which the masks are fitted may also be coated with an adherent tape, e.g. of polyethylene, fluorocarbon, polyvinyl chloride and copolymers thereof or polyester film, or with an insulating medium such as silicone grease or a fluorocarbon suspension. Such a coating helps to accommodate irregularities or variations in the surface of the blank and acts as a gasket between the contact edges of the mask and the blank.

A preferred construction of mask and masked cathode assembly in accordance with the invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a front elevation of a cathode shaped to receive the masks;

Figure 2 is a broken front elevation of the cathode of Figure 1 with a pair of masks in position;

Figure 3 is a plan view of one mask on a larger scale;

Figure 4 is a cross-sectional view of the mask taken along the line 3-3 of Figure 3; and

Figure 5 is a further enlarged cross-sectional view of the mask taken along the line 4-4 in Figure 3.

The cathode 1 shown in Figures 1 and 2 comprises a laminar cathode blank 10 provided with lugs 11 at the top. The cathode blank 10 has faces, including a bottom edge face 16 and two side edge faces 21, on which a removable electrodeposit of metal can be formed, and may itself, be formed of rolled copper, stainless steel, titanium or any other metal or composite structure capable of resisting the corrosive environment of the plating bath and of transmitting the plating current. The lugs 11 are attached to a conductor bar 12, by rivets 13, or by other suitable means, e.g. bolting or welding. In the bottom edge 16 of the cathode blank 10 is formed an inverted V-section groove 17. The side edge portions 14 of the blank 10 are notched at 18 to a dove-tailed shape between the surfaces 19, which are inclined at an angle of less than 90° to the side edge faces 21, to retain masks 24 as shown in Figure 2.

The construction of a mask is shown in more detail in Figures 3 to 5.

The mask 24 consists of a strip of electrically insulating material having a channel 34 recessed in the face 33 and defined by a bottom wall 26, a pair of longitudinal side walls 28 and a pair of end walls 27. The inner surfaces 32 of the side walls 28 are concave so that, as seen in Figure 5, the mouth opening of the channel is slightly smaller in width than the bottom wall 26 of the channel. These side walls 28, which should be at least 0.02 inch thick, and, more usually, from 1/16 to 1/4 inch thick, are resilient so that they can be flexed to widen the mouth opening as required. The inner surfaces 29 of the end walls 27 are inclined so that the bottom of the channel has a somewhat greater length than the top of the channel, and the angle between the inner surface 29 of the end wall 27 and the end wall top surface 31, is less than 90°, e.g., 75°. Thus, the longitudinal cross-section of the channel, as shown in Figure 4, is a dove-tail adapted to mate with the similarly shaped side edge portions 14 of the cathode blank 10. As shown in Figure 5, the angle between the top surfaces 33 and the inner surfaces 32 of the side walls 28 is substantially less than 90° so as to define a sharp edge to the channel opening. The overall length and width of the channel 34 are both slightly smaller than the dove-tailed shaped edge portion of the blank 10 with which they must mate, so that the mask must be stretched to fit it into place.

On releasing the tension a snug shrink fit is obtained and the complementary mating inclined surfaces 19 and 29 interlock to prevent accidental dislodgement of the masks during inspection and stripping or during thermal cycling which results from alternating plating and stripping. It will also be noted that the sharp edges of the channel in the mask provide a line contact with the cathode faces along the lips of the channel which effectively prevents copper from building up under member 24. One top surface 31 of each mask butts firmly against one end of the bottom edge face 16 of the blank to close the end of the V-section groove 17.

In operation, the pair of masks enveloping the side edge faces of the cathode blank effectively prevent deposition of copper along the side edge faces of the cathode blank, while the V-section groove in the bottom edge face of the cathode blank causes the copper to deposit at this edge face in the form of dendrites which grow in directions normal to the sides of the V-groove. Where the dendrites meet in the course of their growth a plane of weakness is established. In stripping the deposited copper from the two major faces of the cathode blank, the copper separates from the major faces following the sharp edges of the masking members, and as the stripping operation proceeds toward the bottom edge of the cathode, the

copper deposited at the bottom edge face will fail along the plane of weakness so that the major face deposits can be separated from the cathode blank. The stripped cathode blanks can of course be reused.

In electrolytic refining, it is a common practice to coat the faces of the cathode blanks with a parting film, e.g. of oil to facilitate the stripping operation, and such coatings may be used on the cathode assemblies of the present invention if they are required to ensure parting of the deposited metal from the substrate. However, it has been found that it is unnecessary to provide titanium cathode blanks with such a coating.

In a practical example, a pair of polypropylene masks constructed as described and shown in Figures 3 to 5 were immersed in water at a temperature of 190°F, for 5 minutes to render them stretchable. After stretching them over the dove-tailed side edge faces of a cathode blank they were cooled, and thereby shrink-fitted into place. After cooling, the masks were found to be stretched about $\frac{3}{8}$ inch in a total length of 40 inches and to be very securely mounted on the cathode with the contacting edges of the masking members and the cathode in sealing engagement.

A series of such masked cathode assemblies after coating with a dielectric oil mixture, were placed in a plating tank between crude copper anodes, with masks extending from a point adjacent the bottom edge face of the cathode to a point on the cathode above the level of the electrolyte, which was an aqueous solution of 40 g/l of copper and 200 g/l of sulphuric acid at 150°F. After electrodeposition of copper at a current density of 18.3 amps/ft² for 13.3 days, giving an average deposit of 295lbs of copper on each cathode, the cathode assemblies were removed from the electrolyte and the copper deposited thereon was readily stripped without dislodging the masks. The stripped copper was smooth-edged where it had been adjacent the masks and had a thickness of $\frac{1}{4}$ to $\frac{3}{8}$ inch. Removal of the insulating masks from one cathode blank showed that substantially no copper had been deposited in the area protected by the masks. This indicated that a sealing contact had been

attained between the masks and the cathode blank.

WHAT WE CLAIM IS:—

1. A cathode assembly comprising a laminar cathode blank having faces, including a bottom edge face and two side edge faces, on which a removable electrodeposit of metal can be formed, with the bottom edge face having a V-section groove extending longitudinally therein to facilitate removal therefrom of an electrodeposit when formed thereon, and further comprising stretchable, electrically insulating masks adapted to be removably shrink-fitted over the side edge faces to prevent electrodeposition of metal thereon and thereby facilitate removal from the blank of an electrodeposit when formed on the blank.

2. A cathode assembly according to claim 1 in which the masks are made of polypropylene.

3. A cathode assembly according to claim 1 or claim 2 in which the masks are adapted to be mechanically retained in position by engagement between dove-tailed surfaces at the extremities of the side edge faces and corresponding surfaces inside the masks.

4. A cathode assembly according to claim 3 wherein each mask in a strip of material having recessed in one face thereof an elongated channel wider at its bottom than at its opening and adapted to receive the respective side edge face of the blank, the longitudinal side walls of the channel being concave, the angle between each longitudinal side wall of the channel and the adjacent surface of the strip face having the recess being less than 90° so as to form sharp side edges to the channel opening, and the end walls of the channel being undercut from the opening to engage the dove-tailed extremities on the respective cathode blank edge face.

5. A cathode assembly according to claim 1 substantially as hereinbefore described with reference to the accompanying drawings.

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COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale

